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February 20, 1947

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U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Lt. Col. R. W. Cook

KZ 3608 5 A

Dear Sir:

Attached is a report on the recovery and disposal of radioactive material in plant waste at K-25 which is submitted in answer to the request of your office on 6 December 1946.

Very truly yours,

C. N. Rucker

C. N. Rucker, Jr.
Assistant Plant Superintend

C.N.Rucker,Jr.
RWL/jw

Copies: 1, 2 - Lt. Col. R. W. Cook
3 - C. E. Center
4 - R. W. Levin
5 - C. N. Rucker, Jr., file

This document has been approved for release to the public by [illegible] Date
Technical Information Officer
Oak Ridge K-25 Site

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CLINTON ENGINEER WORKS
CARBIDE AND CARBON CHEMICALS CORPORATION
Uranium Control and Inspection Department

REPORT NO.
K-3608

February 20, 1947

Recovery and Disposal of Radioactive Material in Plant Waste at K-25

R. W. Levin

Introduction

A discussion of the recovery and disposal of radioactive material in plant waste at K-25 is largely concerned with uranium contaminated material. There are other radioactive materials than uranium at K-25 such as radium-beryllium neutron sources but these are so few in number and only rarely produce radioactive wastes that they constitute no major problem at this time.

The operation of the gaseous diffusion plant produces small amounts of uranium waste in the form of solutions, oils, carbon and alumina, and scrap metal. In addition there is a constant deposition of uranium compounds on the metal surfaces in the cascade.

A general flow diagram of materials contaminated with uranium is given in Figure I. This shows the major recovery problems to be:

1. Recovery of uranium from metal surfaces removed from process gas service.
2. Recovery of uranium from oils.
3. Recovery of uranium from carbon.
4. Recovery of uranium from activated alumina.
5. Recovery of uranium from water media.

The extent of recovery or removal of uranium from these materials and the disposition of the wastes should be based on several factors. These are cost of recovery, health hazards due to insufficient removal of uranium, accountability, and diversion control.

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Status of Recovery Problems

Recovery of uranium from metal surfaces removed from process gas service

There is a fairly constant deposition of uranium compounds on the metal surfaces of the cascade. The estimated rate of this consumption has been reported by Mr. J. P. Kelly, "Consumption Estimates", A-3666, January 10, 1947. Whenever equipment is removed from process gas service it is necessary to remove the small amount of uranium on the metal surfaces before the equipment can be safely serviced or repaired. There are two general methods of removing the deposits:

1. Washing the equipment with an appropriate solution.

2. Fluorinating the equipment with F_2 to form volatile TF_6.

The first method is used by Cascade Services Decontamination Unit in K-1303 and is described in detail in the Process Division Standard Operating Procedures, series 900. Completeness of decontamination is determined by moistening a test paper with 1% potassium ferrocyanide solution and rubbing the paper over several surfaces of the item decontaminated. This test shows the absence of any soluble uranium compounds, but does not detect insoluble compounds such as TF_4.

The second method is used almost exclusively for recovery of uranium from converters for consumption studies and is carried out in K-1401. Completeness of fluorination is determined by gas analysis.

Solutions obtained from the Decontamination Unit are sent to a contaminated storage lot pending determination of the desirability of recovery. Converters removed from process gas service are not routinely fluorinated, but are placed in storage without recovery. Equipment which has been decontaminated is then repaired for use, placed in storage, or declared surplus or scrap. Surplus or scrap material is not examined for radioactivity at the present time since the amount of radioactivity from uranium compounds left on the surfaces is well below tolerance for personnel safety. However, an investigation is being made of procedures for use in determining the absence of low level radioactivity.

Recovery of uranium from oils

There are two types of oils which become contaminated with uranium. The first is special fluorinated oils and the second is regular hydrocarbon oils. During the past year the amount of these oils in process gas service has been greatly reduced, and only very small quantities of contaminated oils are produced. About three fourths of the backlog of contaminated oils has been reworked for uranium recovery. The decontaminated oil is then sent to storage for reuse; however, a process for reclaiming the uranium from the oil filter cake has not been developed, and the filter cake is being stored.

Recovery of uranium from carbon and alumina

During the early operation of the plant, large amounts of contaminated carbon and alumina were produced, but during the past year the number of traps in active service has been appreciably reduced so that normally less than 200 pounds of uranium per month is trapped in carbon and alumina. The Engineering Development Division is developing methods of recovery of uranium from carbon and alumina, and an appreciable fraction of the backlog of contaminated carbon has been reworked in the process of developing satisfactory methods.

Recovery of uranium from water media

Solutions obtained from decontamination of equipment and spills, and from laboratory or experimental wastes are sent to contaminated storage prior to recovery of the uranium as an oxide and subsequent conversion to TF_6. The desirability of recovering uranium from waste solutions or carbon and alumina for use as a feed to the cascade should be considered on the basis of economy of operation as well as accountability and diversion control. The cost of recovery can be compared with the value of the increased cascade production due to the additional feed of recovered TF_6. A report recommending limits for discarding contaminated waste solutions and carbon on this basis has previously been issued to Lt. Col. R. W. Cook on January 16, 1947.

Inventory of Radioactive Wastes Stored at the Plant, and Amount of Waste Reworked

Tables I - 3 show the amounts of waste reworked, amounts of uranium recovered, and the inventory of uranium bearing waste material on 31 December 1946. The largest uranium inventory in waste is in spent carbon and nearly all of this is feed concentration or less.

Figures 2 - 10 are flow sheets and descriptions of the processes used in reworking waste materials.

Acknowledgement

Figure I and Tables I - 3 were prepared by Mr. F. Mills. Acknowledgement is made for permission to use figures 2-10 prepared by K-25 Division U.S.A.E.C.

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FIGURE 1

FLOW SHEET OF MATERIALS CONTAMINATED WITH "T

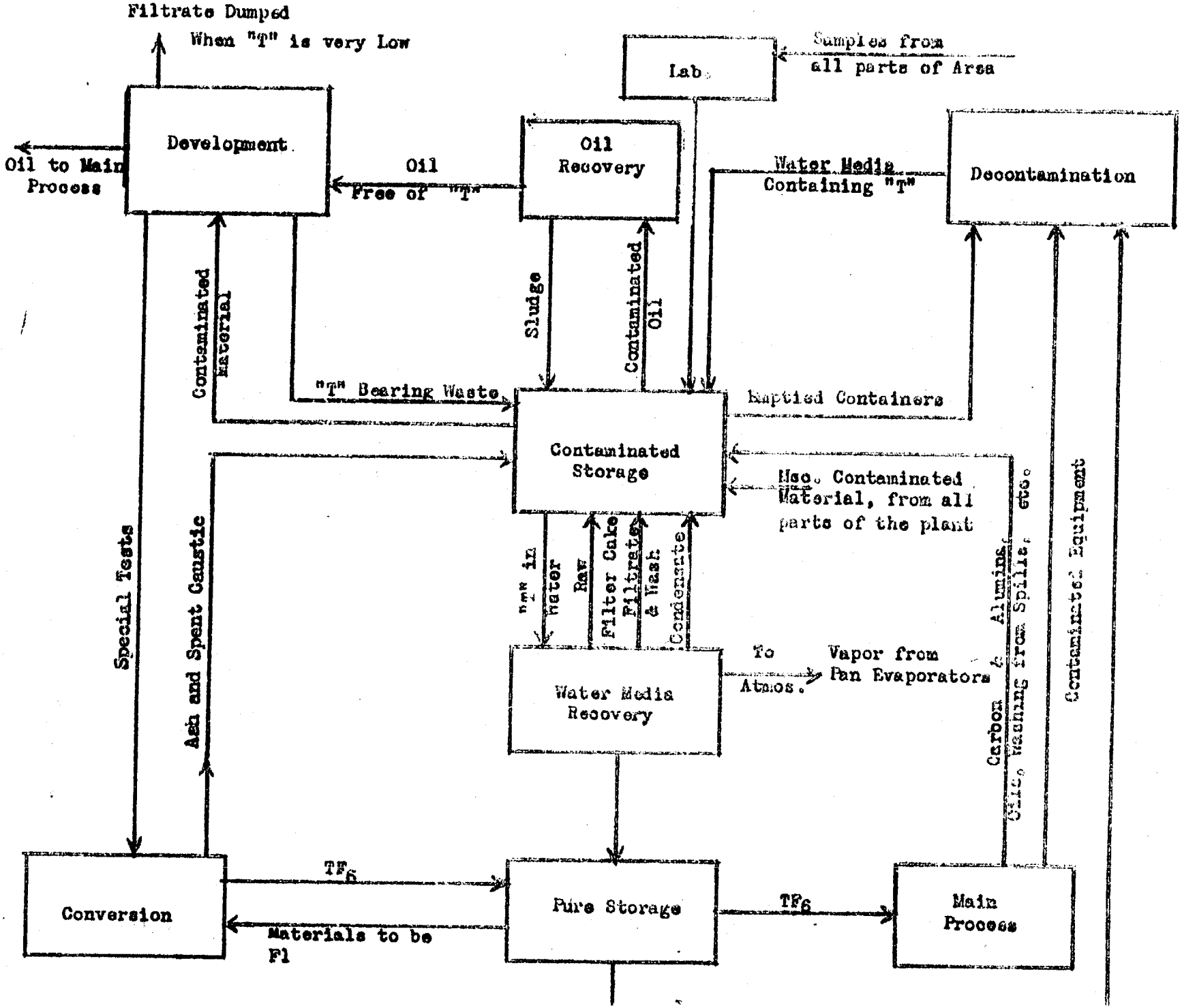

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FIGURE II

THE RECOVERY OF "T" FROM CONTAMINATED MATERIAL

CONTAMINATED STORAGE

1 Contaminated Solutions
- (a) Solutions from process equipment decontaminated in place → Decontamination Carbonate water, or Hydrogen peroxide solutions
- (b) Experimental users' waste → Carbonate solutions, but may be any type
- (c) Laboratory waste → Lab. Waste Solutions
- (d) Leak Solutions from recovery processes (stored) → Shipped to contaminated storage

2 Contaminated Equipment
- (a) Residue in cylinders
- (b) Pumps and Seals
- (c) Valves and pipes
- (d) Gloves and clothing
- (e) Line recorder cold traps

→ Contaminated equipment heated in dilute Na_2CO_3 sol'n. Sol'n and sludge contain "T" Four Classified tanks used and one wash tank. Sampling - C.D., and E tanks sampled Mon. Tues. Wed. Thur. All tanks sampled

- (f) Converters → 3

3 Fluorocarbons → 4
- (a) Mixtures of TF_6 and C-816 removed from cascade at or near 301-4
- (b) Mixtures of TF_6 and Freon and other fluorocarbons removed from cascade at 306-7.6

→ 200 g. withdrawn once and sent to laboratory for analysis

4 Contaminated Oils → 5 → 6
- (a) MFL from Beach-Russ pumps
- (b) 2144 from valley iron pumps
- (c) Hydrocarbon Oils (stored)

5 Contaminated Filter Cakes
- (a) Cake following MFL or 2144 recovery (stored)
- (b) Cake from recovery of decontamination (sol'ns (stored)

→ Development of Process not complete

6 Carbon
- (a) Seal exhaust traps
- (b) Carbon traps in cold trap rooms
- (c) Section 601 and 631 carbon traps
- (d) Portable carbon traps
- (e) Mobile carbon traps (The carbon is emptied from the traps into 30 or 55 gallon drums)

→ Process being developed 7

7 Activated Alumina
- (a) Alumina traps from 312 buildings
- (b) Alumina traps from purge and product room

→ Process being developed 8

Contaminated Materials Storage samples material as received except in instances where the analysis is known. Material is classified as follows:

A	Normal
B	Normal - 2230001
C	2230001- 3480003
D	3480003- 2810001
E	2810001- 31220002
L	31220002-11070002

FIGURE 3

DECONTAMINATION SOLUTIONS AND LABORATORY WASTE SOLUTIONS

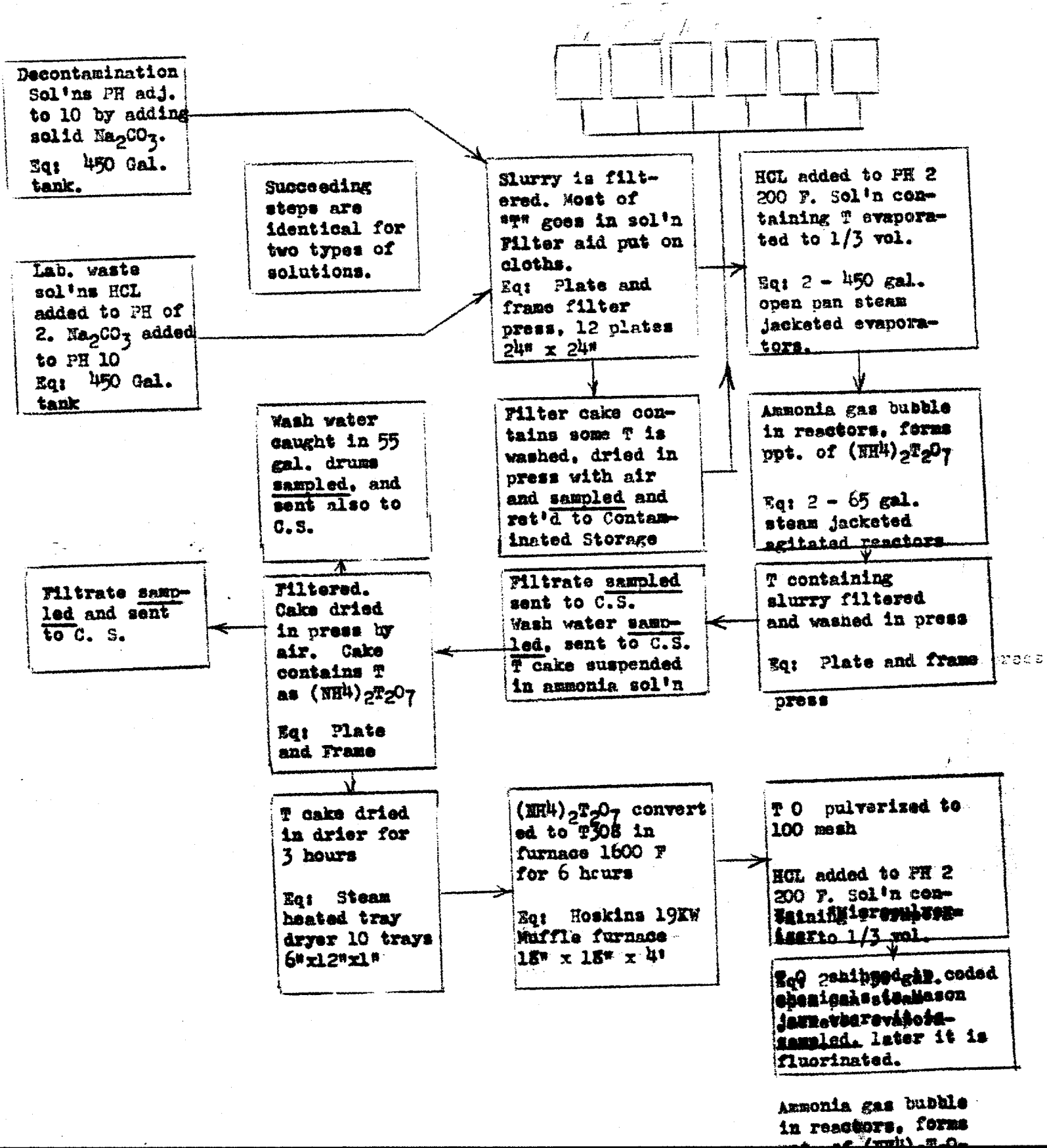

FIGURE IV

FLUORINATION OF T_3O_8 TO TF_6

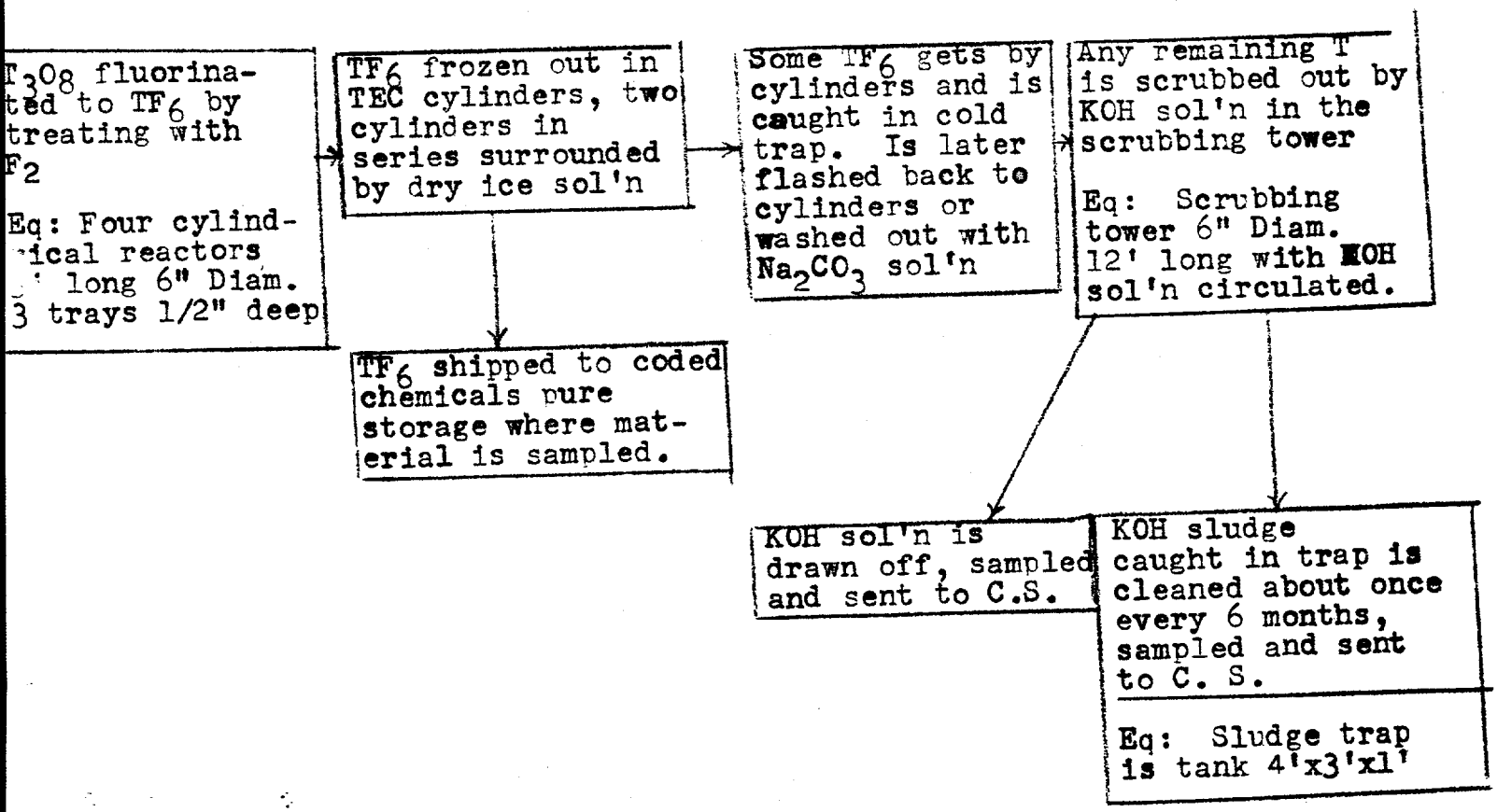

FIGURE 5

RECOVERY OF "T" FROM CONVERTERS

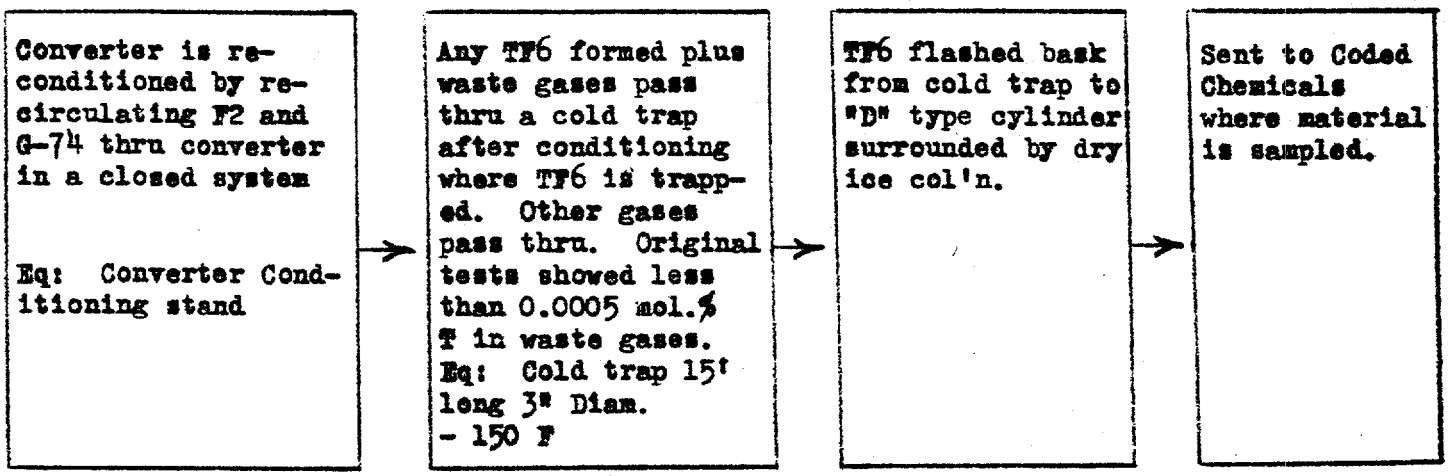

FIGURE 6

RECOVERY OF "T" FROM MIXTURES OF TF6 AND C-816 REMOVED FROM THE CASCADE AT OR NEAR 301-4

(THIS HAS BEEN ABANDONED IN FAVOR OF A STILL COLUMN NOW IN PROCESS OF DEVELOPMENT)

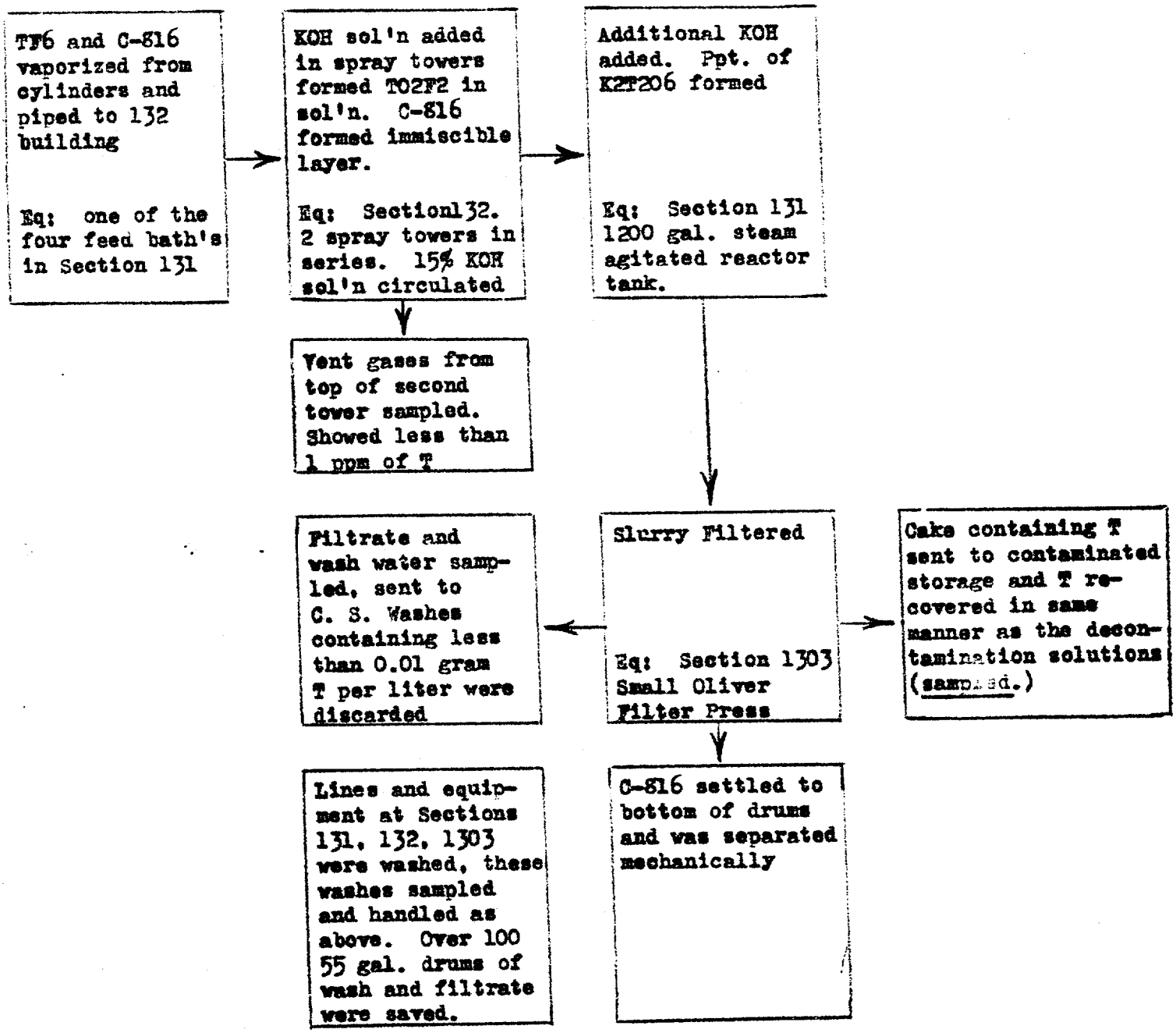

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FIGURE 7

RECOVERY OF "T" CONTAINING CAKE FOLLOWING THE RECOVERY OF MFL

NOTE: RECOVERY OF "T" FROM CAKE HAS NOT BEEN DEVELOPED YET

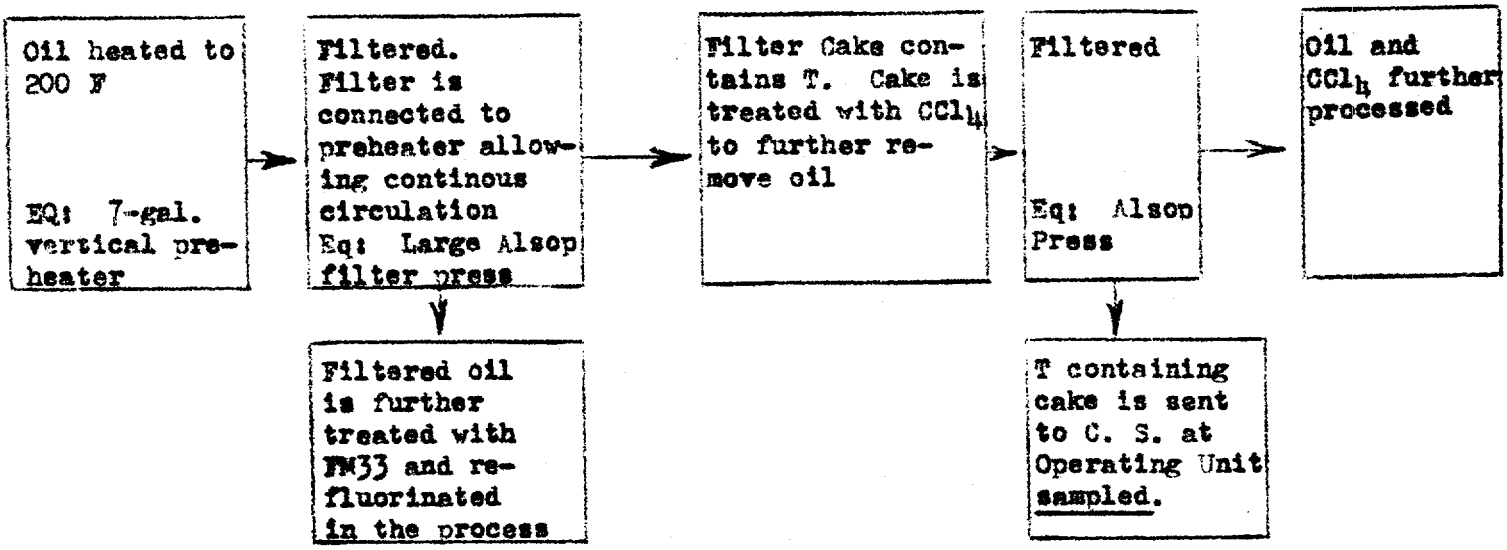

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FIGURE 8

RECOVERY OF "T" CONTAINING CAKE FOLLOWING THE RECOVERY OF 2144

NOTE: RECOVERY OF "T" FROM CAKE HAS NOT BEEN DEVELOPED YET

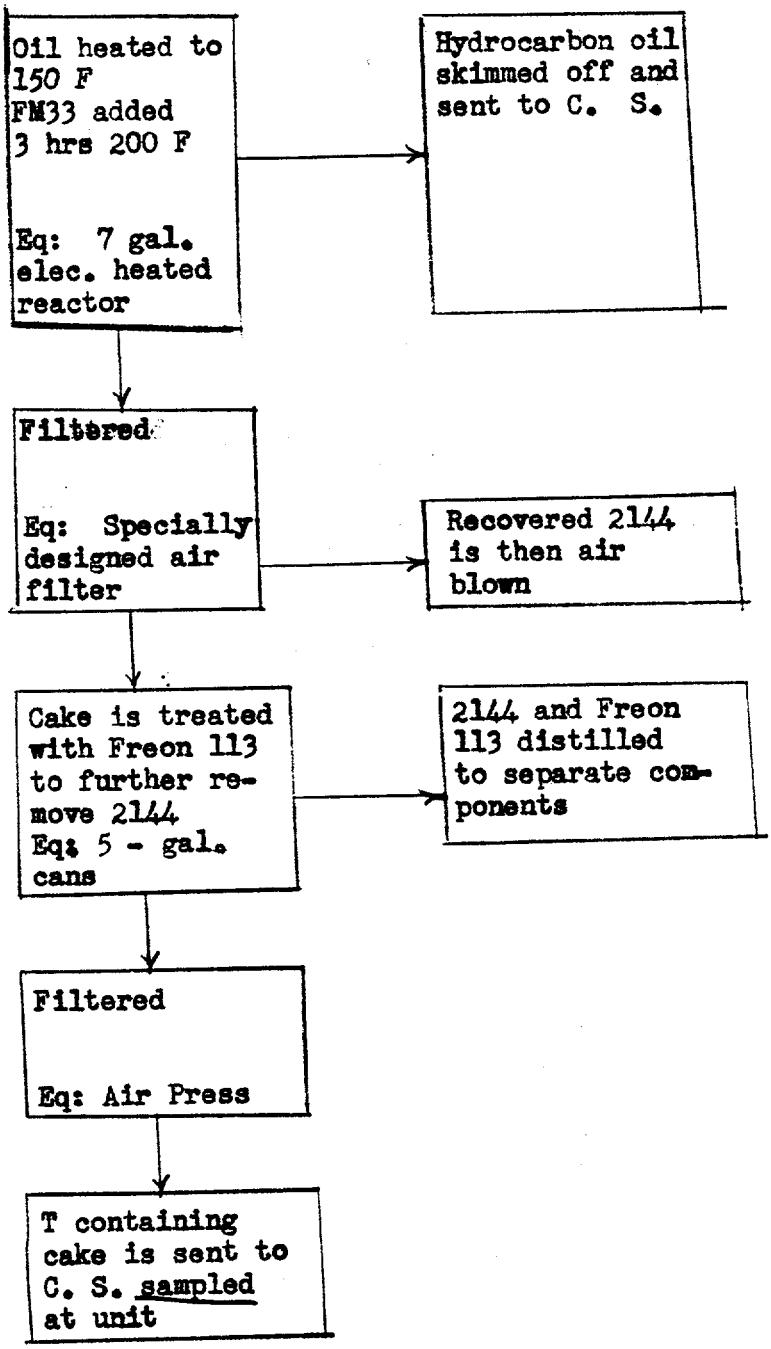

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Figure 9

RECOVERY OF "T" FROM CARBON FROM CARBON TRAPS

THIS PROCESS IS BEING DEVELOPED AT THE PRESENT

The steps in the process are:

1. The separation of the alumina from the carbon. This alumina is being reused in making fresh carbon-alumina mixes.
2. The conversion of the T to T308 in a furnace.

Sampling

The probable sampling points after the process is developed will be the carbon-alumina-T mixture, and the converted T308.

Figure 10

RECOVERY OF "T" FROM ACTIVATED ALUMINA FROM ALUMINA TRAPS

THIS PROCESS IS BEING DEVELOPED AT THE PRESENT

The steps in the process will most likely be:

1. Treatment of alumina and T with Sulphuric Acid, followed by diluting and treating with Nitric Acid.
2. Filtration. Filtrate contains the T, and will be handled the same as decontamination solutions.

Sampling

Probable sample points after the process is developed, will be the alumina and T mixture, filtrates, washes, and precipitates.

TABLE 1

ESTIMATION OF RECOVERED UF_6 FROM REWORKED "WATER MEDIA" AND 816-616 MIXTURE AND THE BY-PRODUCTS FROM MAY 1946 TO JAN. 1947

Form of Material	Disposition	Lbs. or Gals.	Lbs. "U"	Percent Distribution of "U"	Weighted Average Ass Percent "U"
UF_6 Recovered	Fed to Cascade	640.63 lbs.	433.23	49.86	2264305
UF_6 Recovered	As Samples to Laboratory	10.62 lbs.	7.19	.83	2264305
UF_6 Recovered	To Pure Storage Coded Chem.	143.30 lbs.	96.89	11.15	2244082
UF_6 Recovered	Unaccounted and Piping	21.07 lbs.**	14.25**	1.64	2268506
Total UF_6	Fed and in Storage	783.93 lbs.	530.12	61.01	
Caustic Solutions	To Contaminated Storage	3089. gals.	2.88	.33	2256751
Ash from Conversion	To Contaminated Storage	460.55 lbs.	137.29	15.80	2249543
Impure Filter Cake	To Contaminated Storage	2684.7 lbs.	63.02*	7.25	8880287
Filtrate and Wash Water	To Contaminated Storage	13215. gals.	105.39*	12.13	2284667
Filtrate from Sodium Uranate	Dumped by Development Dept.	4000. gals.	nil		
Condensate	To Contaminated Waste	605. gals.	2.52	.29	2240002
Reworked except UF_6	To Laboratory as Samples		6.25***	.72	
Total "U" Completely Reworked			868.91	100.00	
Total "U" in Waste Charged to Recovery From Table 2			986.71		
Unaccounted			-117.80 lbs.		

* No analysis available on about one quarter of the containers and the accuracy of about one half of the filtrate analysis which are available are questionable.

** Claimed lost in transferring Batch 12 from small cylinders to one large cylinder for sampling and feeding.

*** Estimated.

All weighted "U" average assays except UF_6 fed are either estimated or contain estimated figure.

TABLE 2

Amount of Waste Fed to Recovery and Development up to December 31, 1946
(Excluding Carbon and Oils)

Material and Class	Gals. or Lbs.	Lbs. "T"	Estimated "T" Assay
"Water Media" Class A	5313 gal.	782.17	2268006
" " " B	3915 gal.	91.56	2250004
" " " C	4214 gal.	38.46	2280002
" " " D	550 gal.	10.45	2460006
" " " E	6391 gal.	47.30	2270001
Total to Recovery	20,384 gal.	969.94 lbs.	
Development Department All Classes	5,099 gal.	266.32 lbs.	
Total "Water Media" entering a Recovery Process	25,483 gal.	1236.36 lbs.	
Inventory 12-31-46	1,424	339.87 lbs.	
Net Reworked to Recovery Process 12-31-46	24,059 gal.	896.49 lbs.	
616 & 616 Mixture Class B	686 lbs.	268.81 lbs.	
Net lbs. "T" Charged to Re-working		1165.30 lbs.	
Conversion & T_3O_8 Pure Storage		178.59 lbs.	
Inventory 12-31-46			
Net "T" in material Charged to Re-working		986.71 lbs.	

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TABLE 3

"T" Bearing Waste Materials on hand December 31, 1946 Including By-products from Reworked Material (Estimated 12-31-46)

Name of Material	Location	Lbs. or Gal.	Lbs. "T"	Av. "X" As
Filter cake from MFL oil	Development Dept.	51.8 lbs.	17.24	2281325
Filter cake from C-2144 oil	" "	190. lbs.	6.954	2257734
Contaminated C-2144	Contaminated Storage	800 lbs.	2.000	-
Contaminated MFL	" "	2000 lbs.	6.000	
Contaminated oil (C-2144 & Mech)	Oil Recovery	1748.9 lbs.	6.277	
T_3O_8 from Carbon	Development Dept.	2163.75 lbs.	1630.	3358505
Raw Filter cake (Recovery)	Contaminated Storage	2684.7 lbs.	63.02	8880287
Ash (from conversion)	Contaminated Storage	460.55 lbs.	137.29	2249543
Water media, incl. filtrate, wash water, condensate and caustic solutions	Contaminated Storage	35,438 gal.	1033.96	2278475
Carbon and Alumina	Contaminated Storage	272,090 lbs.	21,997.47	-
Carbon and Alumina	Development Dept.	7,525.8	1,412.79	
TF_6 recovered from Converters	Development Dept.		1.05	2290001
Reworked Products in Process at "water media" and oil recovery conversion, decontamination, T_3O_8 pure storage			585.95	
Total Estimate of "T" in Waste Materials (12-31-46)			28,890.00	

Note: All "X" assays estimated or contain estimated figures.

S E C R E T